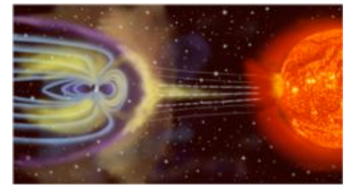
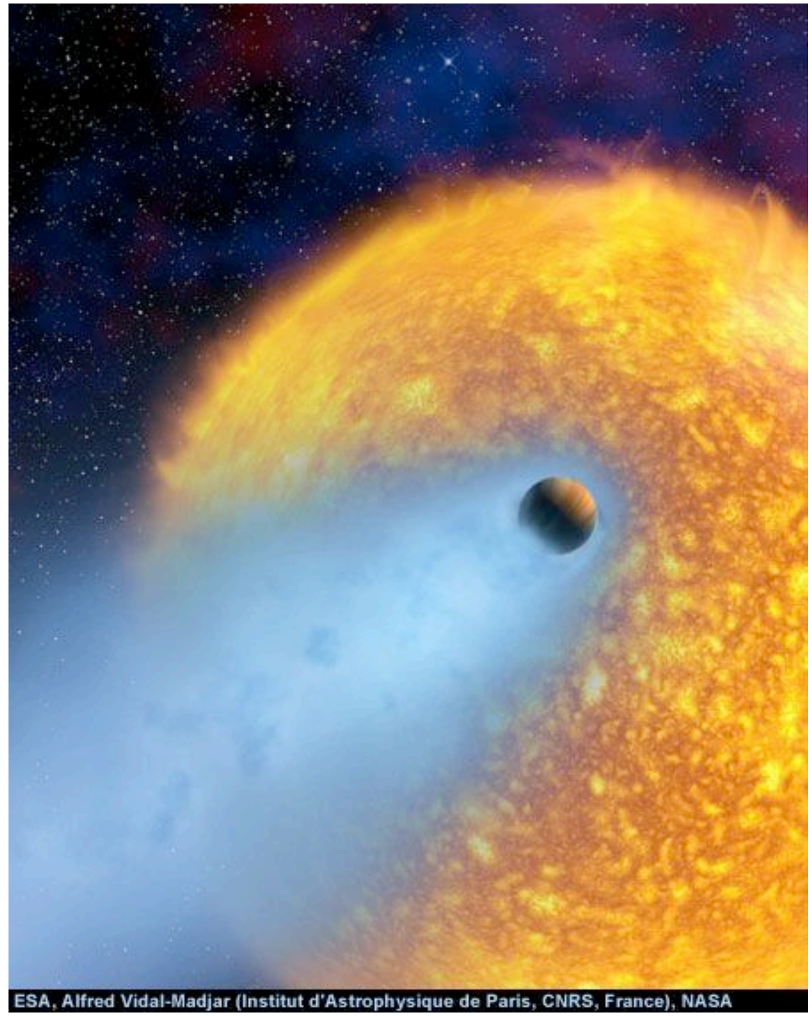
Global aspects of Heliosphere-Geosphere Coupling



T E Moore[1], M-C Fok[1], D C Delcourt[2], S Slinker[3], J Fedder[4], M Buenfil[1]

1. NASA's Goddard Space Flight Center
2. CETP, St.-Maur, France
3. Naval Research Laboratory
4. LET Corp.



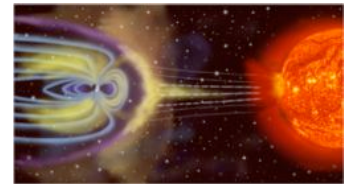
Inferred ablation of Osiris' atmosphere

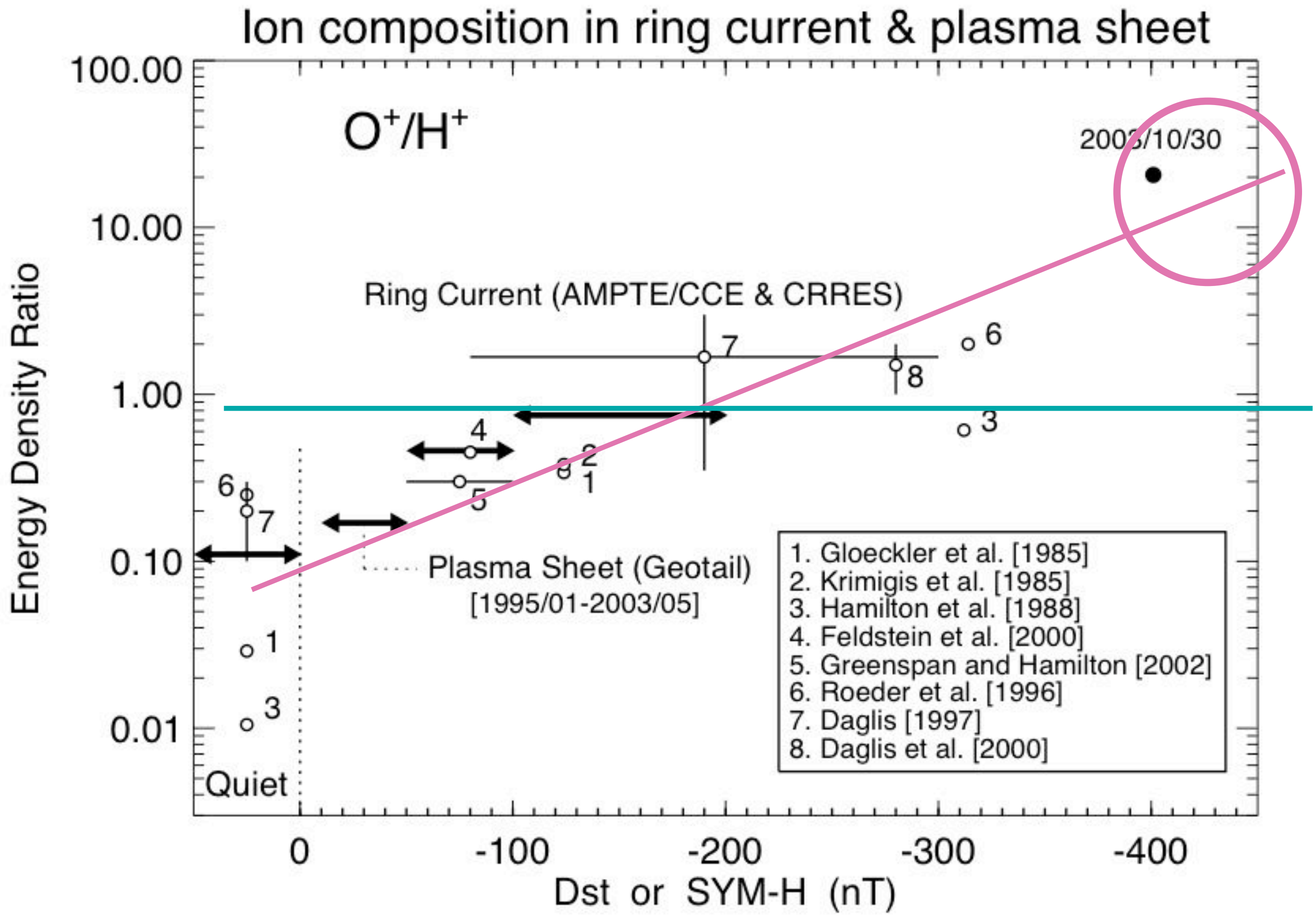
Moore, Fok, et al., JGR Feb 2005 "Solar and Polar Wind…"

Moore, Fok, et al., Geophys. Mono. 159, 2005, "Ionospheric Plasmas in the Ring Current"

Nosé, Christon, Taguchi, Moore, Collier, JGR 2005, "Overwhelming O+…

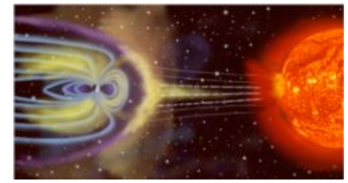
Halloween 2003 on D_{ST} Trend



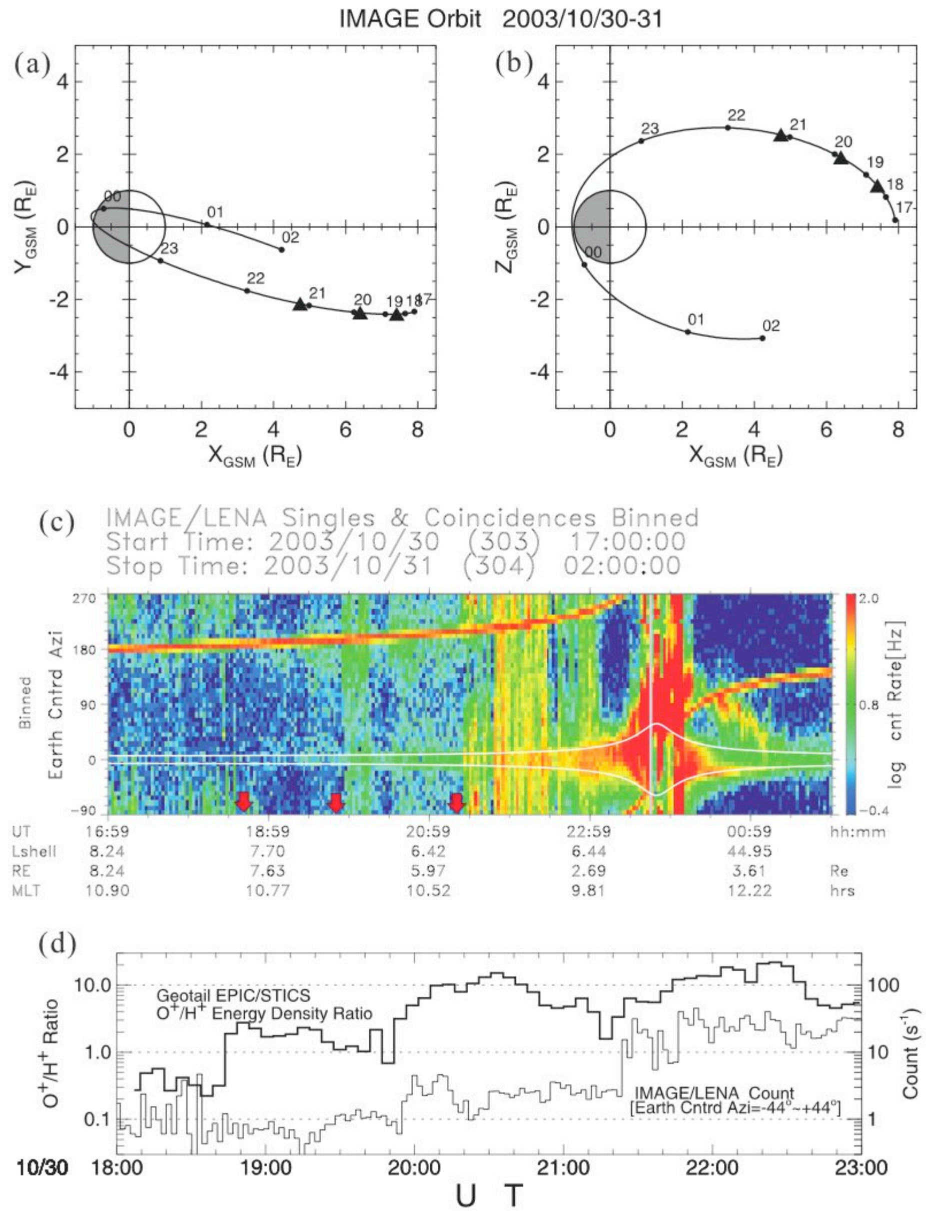


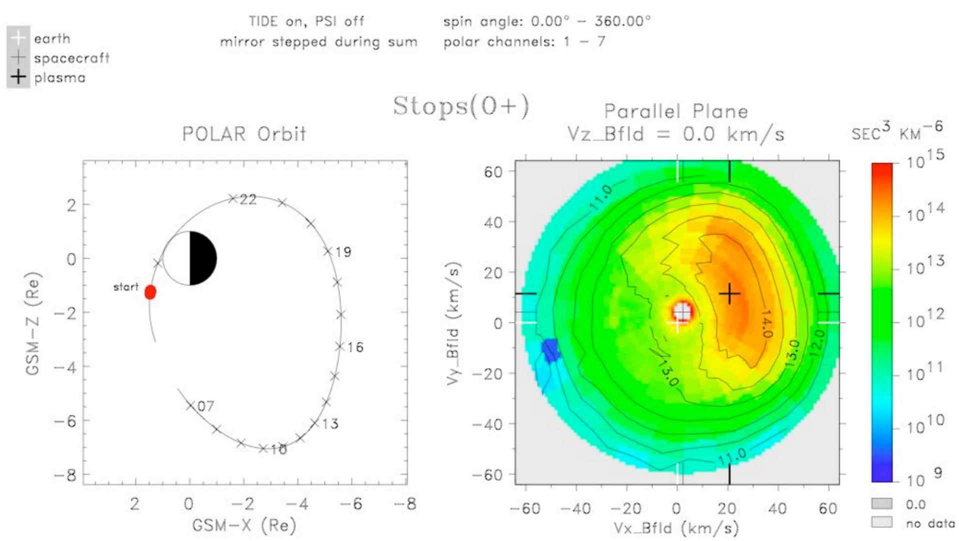
Nosé, Christon, Taguchi, Moore, Collier, JGR 2005, “Overwhelming O+…

Halloween Outflows TIDE and LENA

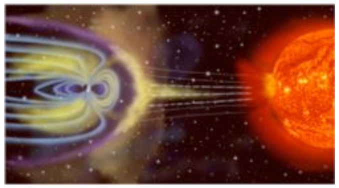


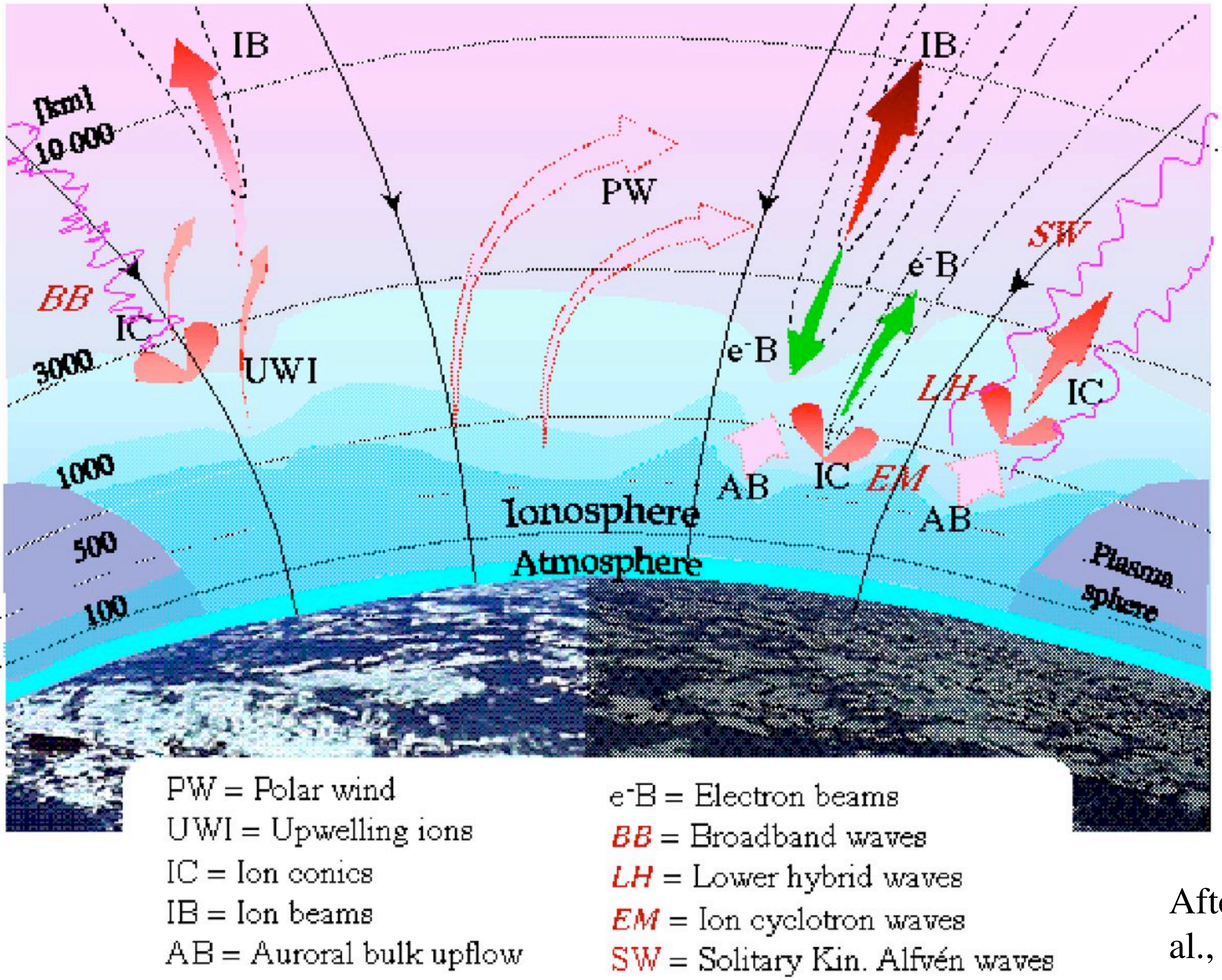
- Largest Polar/TIDE and IMAGE/LENA outflows ever observed
- Ion flux ~1.5 x 10^{10} $cm^{-2}s^{-1}$ is about 10 x flux for 24-25 Sep 1998





Ionospheric Outflow Processes

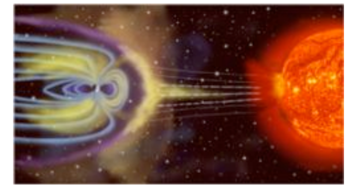


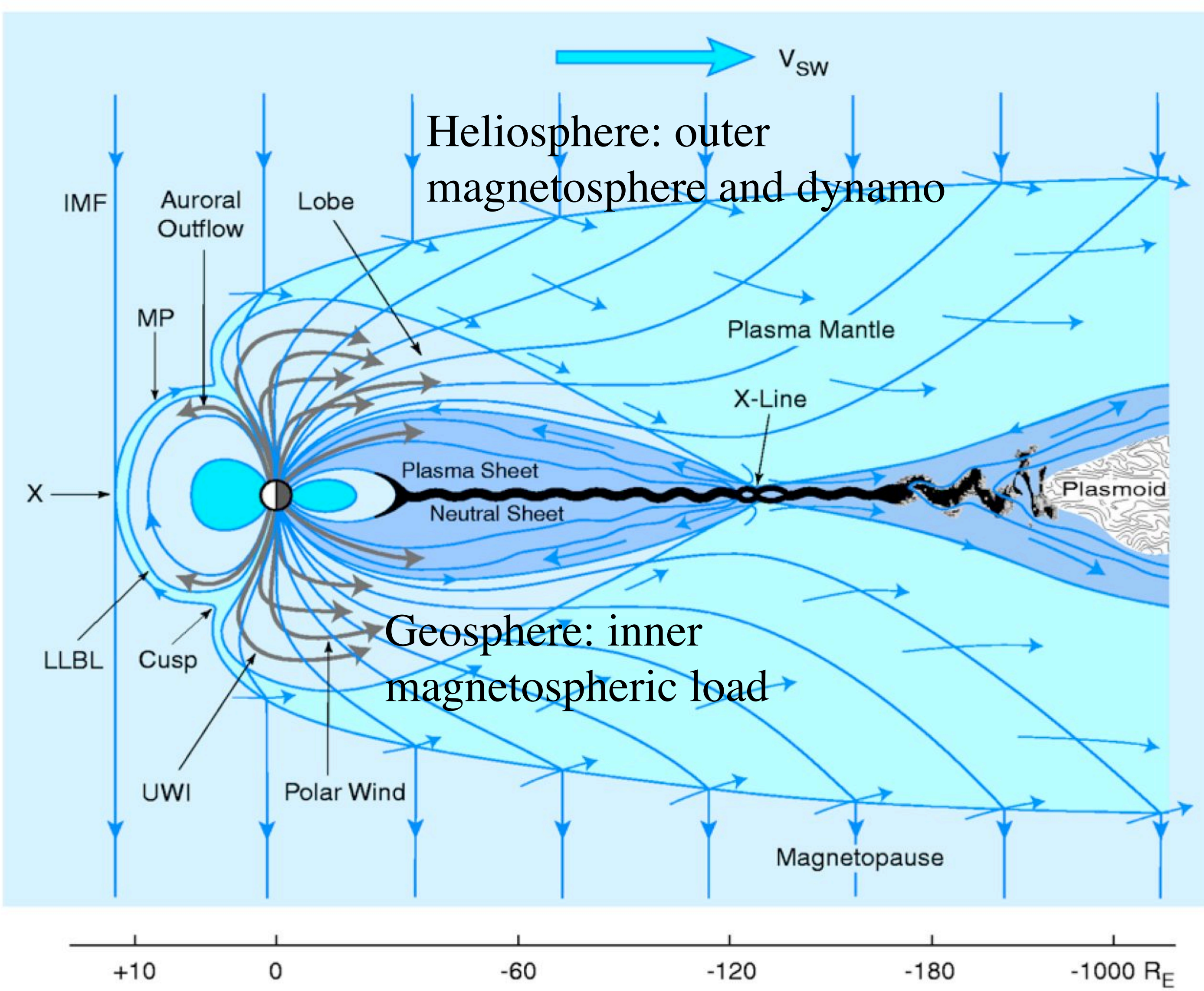


1. Solar Wind
   phototthermal
2. Polar Wind
   photothermal
3. Auroral Wind
   dissipative coupling of solar wind energy

After Moore, Lundin et al., SSR, 1999

Ionospheric Global Circulation





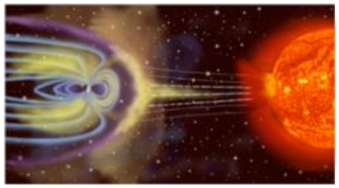
Heliosphere: outer magnetosphere and dynamo

Geosphere: inner magnetospheric load

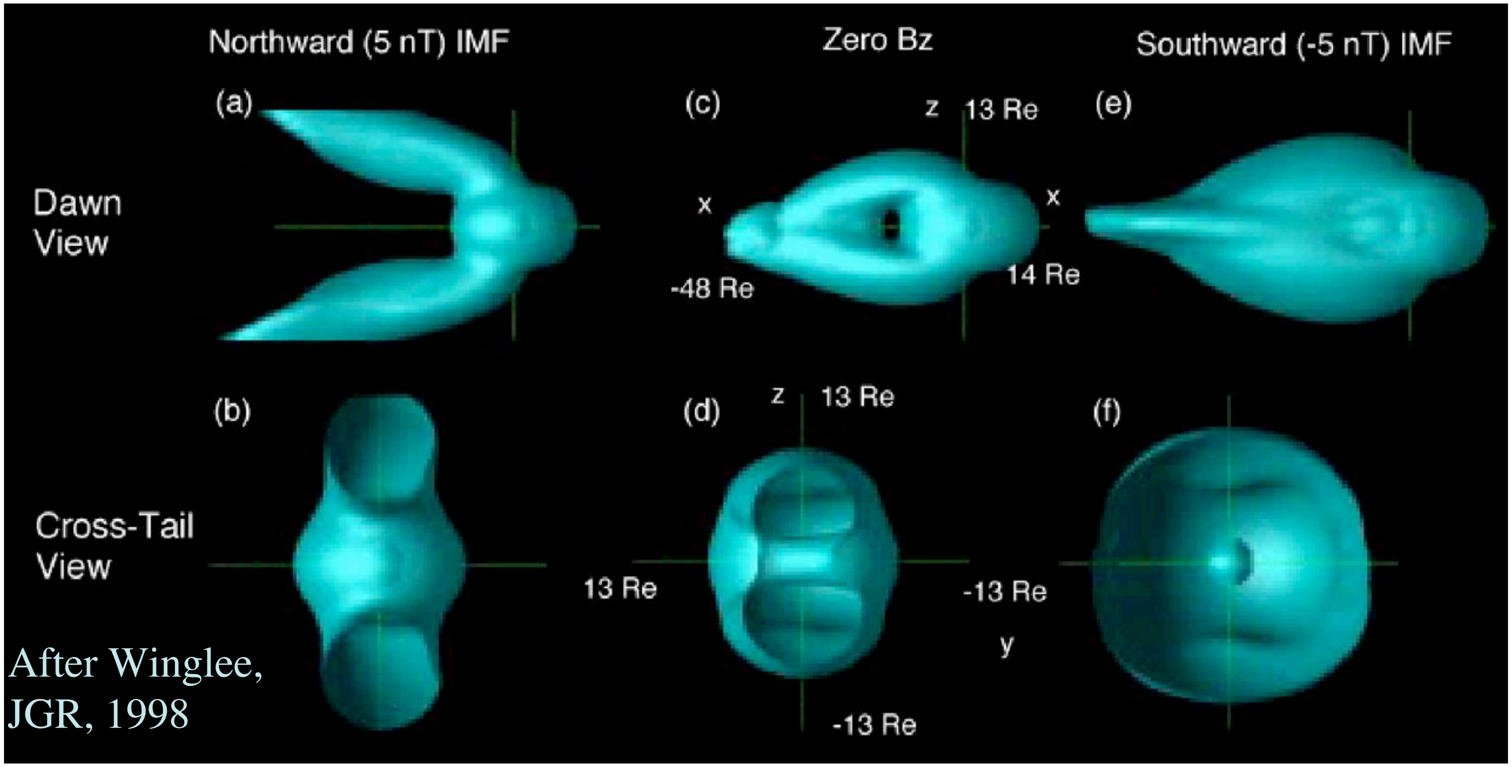
Magnetosphere: electrodynamic coupler of dynamo to load with feedback

After Hultqvist, et al. SSR, 1999

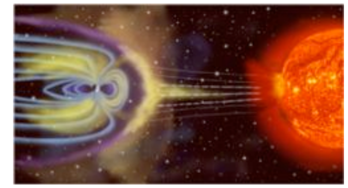
Heliosphere and Geosphere



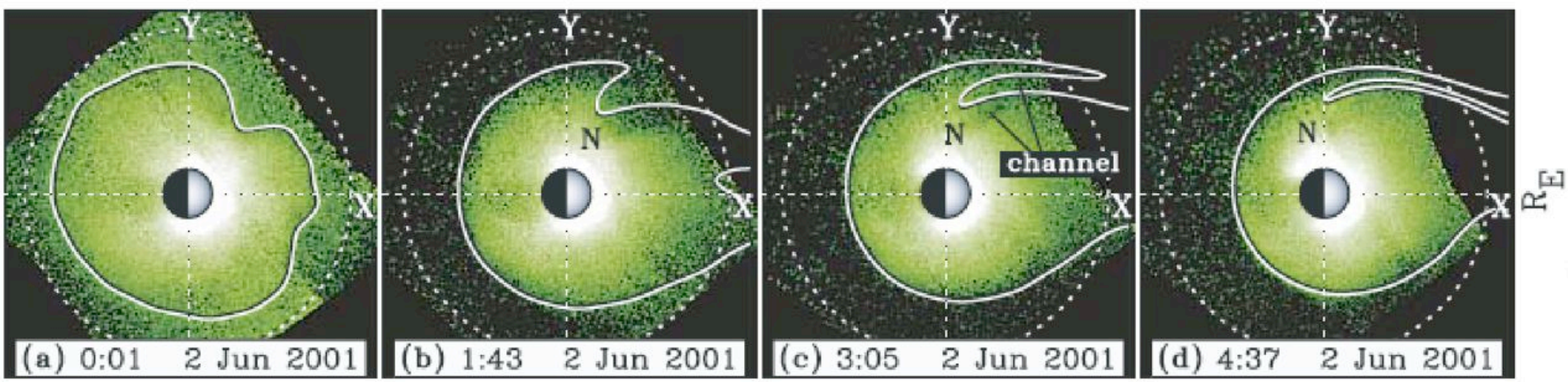
- Full 3D computations have taken us from cartoons into simulations.
- Initial efforts placed all ionospheric dissipation in the F layer, as a boundary condition to the simulations
- Recent innovations include ionospheric plasma fluids



Polar Wind and Plasmasphere

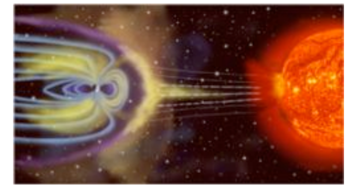


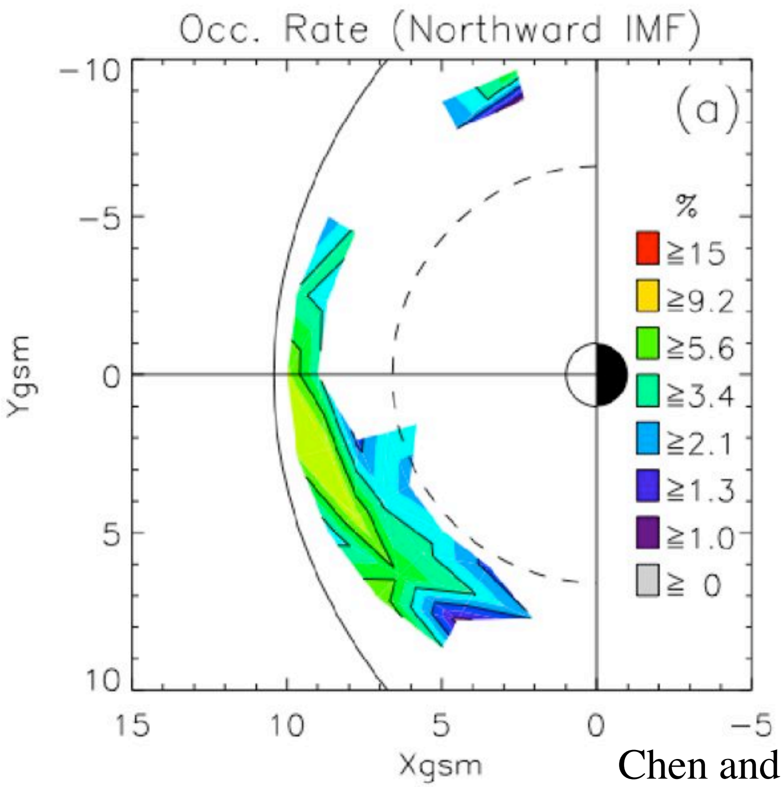
- Detailed dynamics of the extended light ion accumulation in the plasmasphere from the IMAGE mission.
- Basic features understood as effect of enhanced global sunward convection.
- Features such as spokes, ridges, sub-corotation point toward full simulations as dynamic element of the system

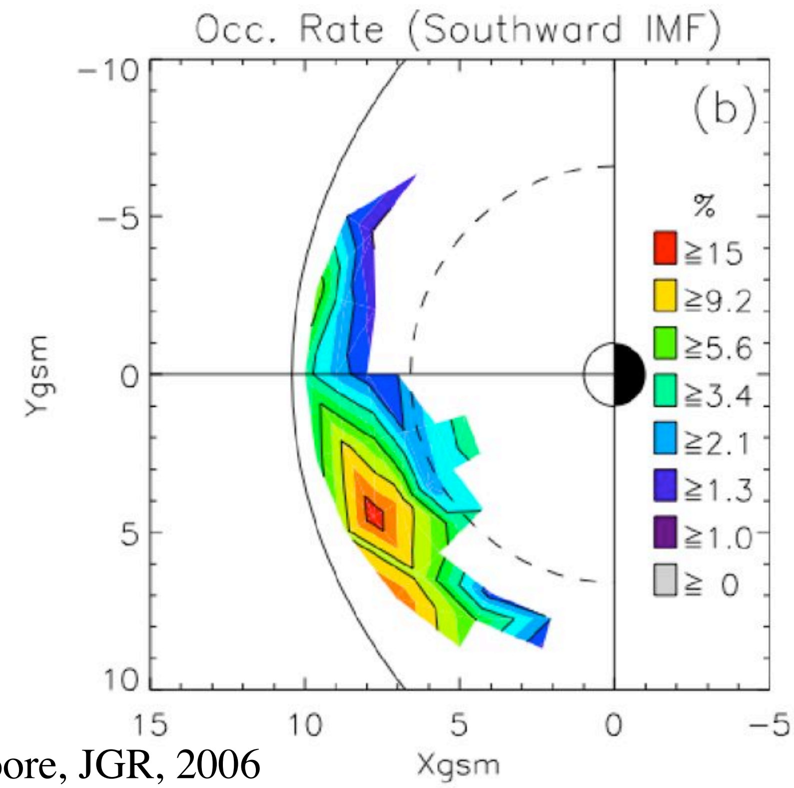


Goldstein, et al. JGR, 2002

Cold Plasma Plumes at M'pause



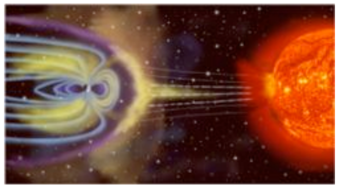




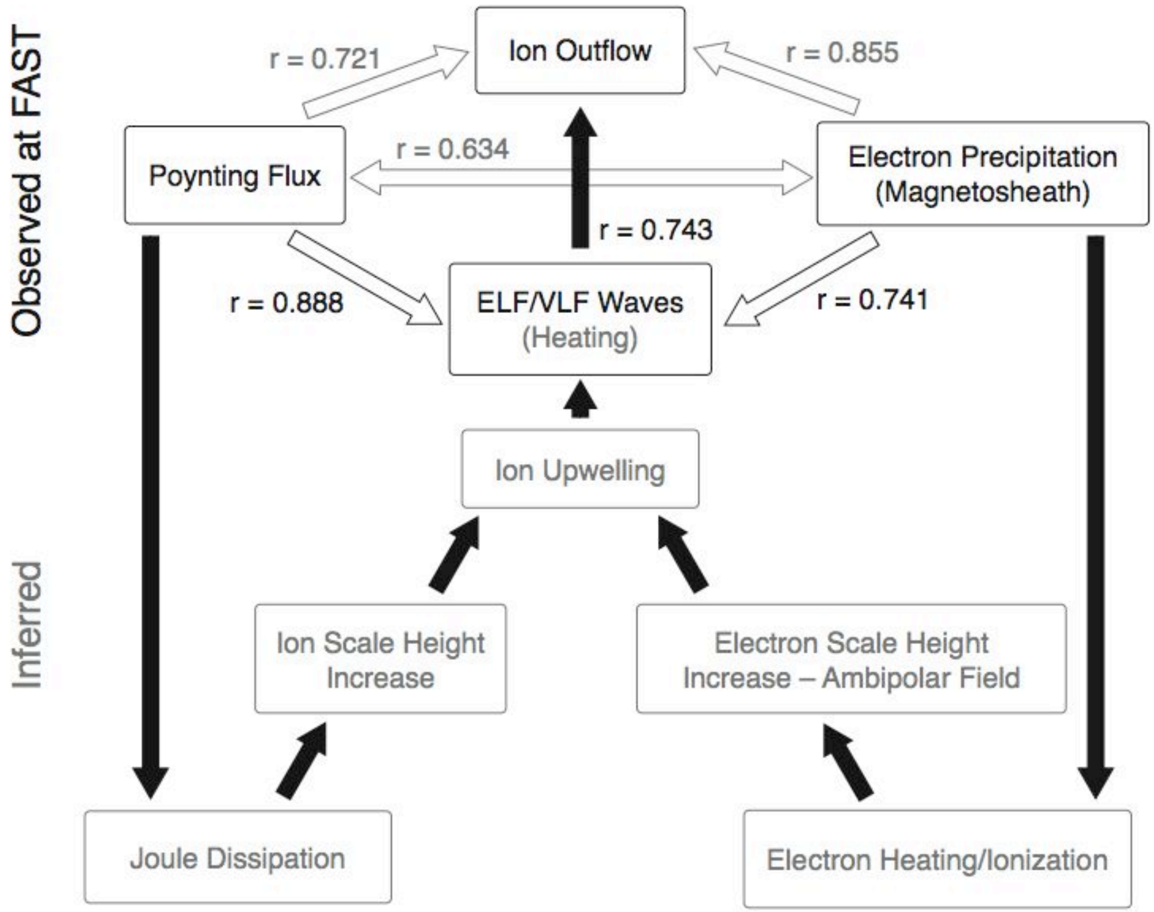
Chen and Moore, JGR, 2006

- Cold plasmas routinely present in the dayside magnetopause region, convecting according to IMF
- Densities increase to ~50 cm-3 during sunward flows
- Likely to load dayside reconnection via local depression of V_A

Quantifying Auroral Outflows

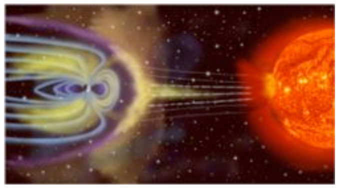


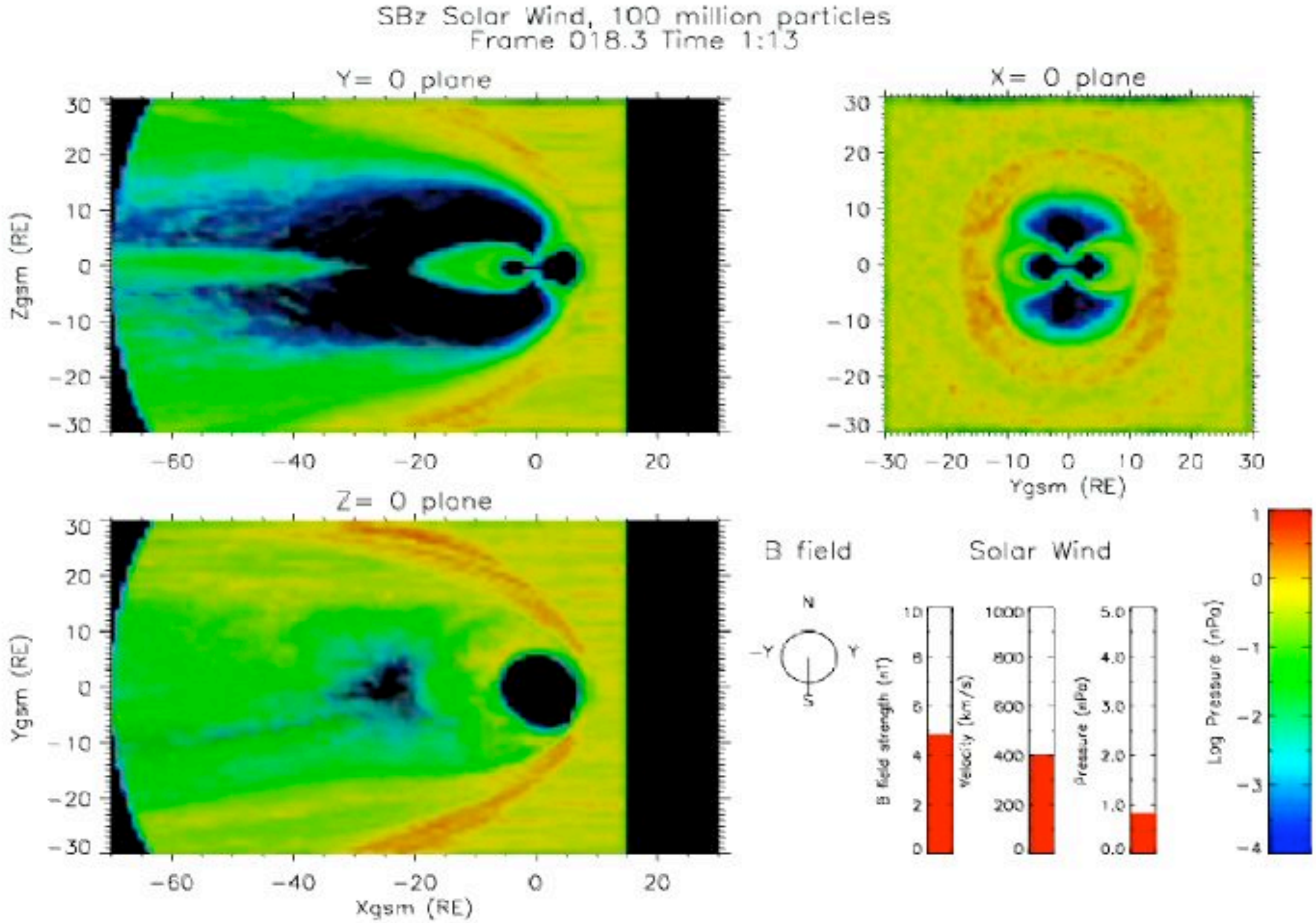
- IMF and Pd relations are inadaquate to specify full spatio-temporal dynamics
- FAST/Polar Empirical:
1. Ion heating:
    1. Friction (300 km)
    2. ICW (3000 km)
2. Electron heating:
    1. Soft e- (300 km)
    2. Hard e- (100 km)
3. “Centrifugal” (pickup 10000+km)



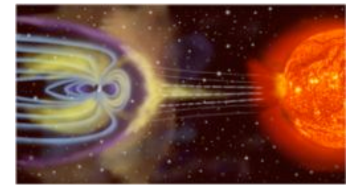
Strangeway et al., 2005; Zheng et al., 2005

Dynamic Solar Wind: SBz Excursion

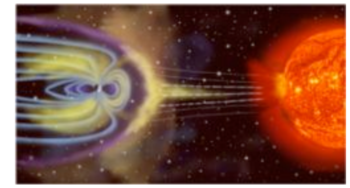


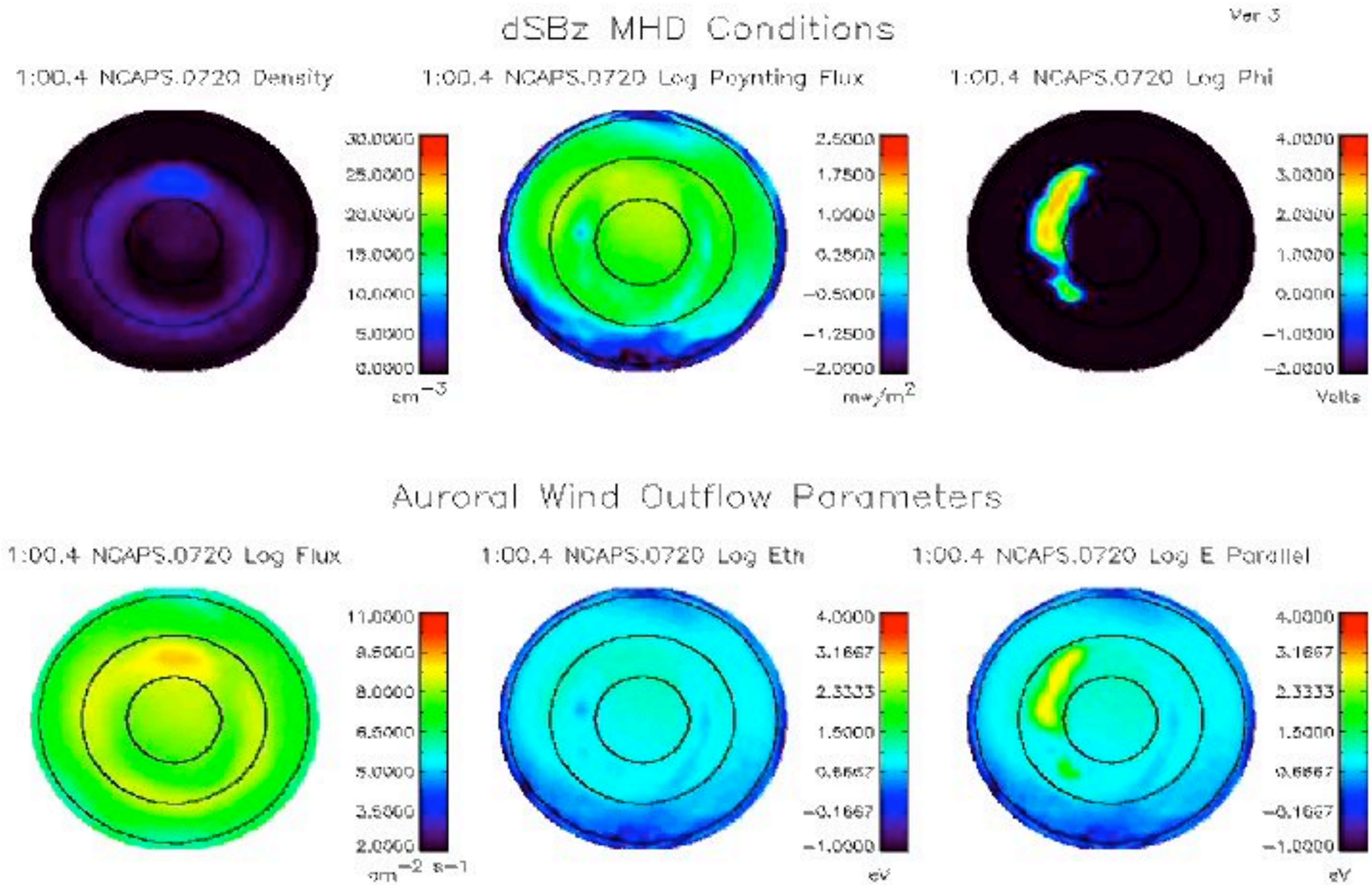


Dynamic Polar Wind: SBz Excursion

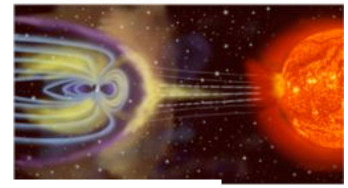


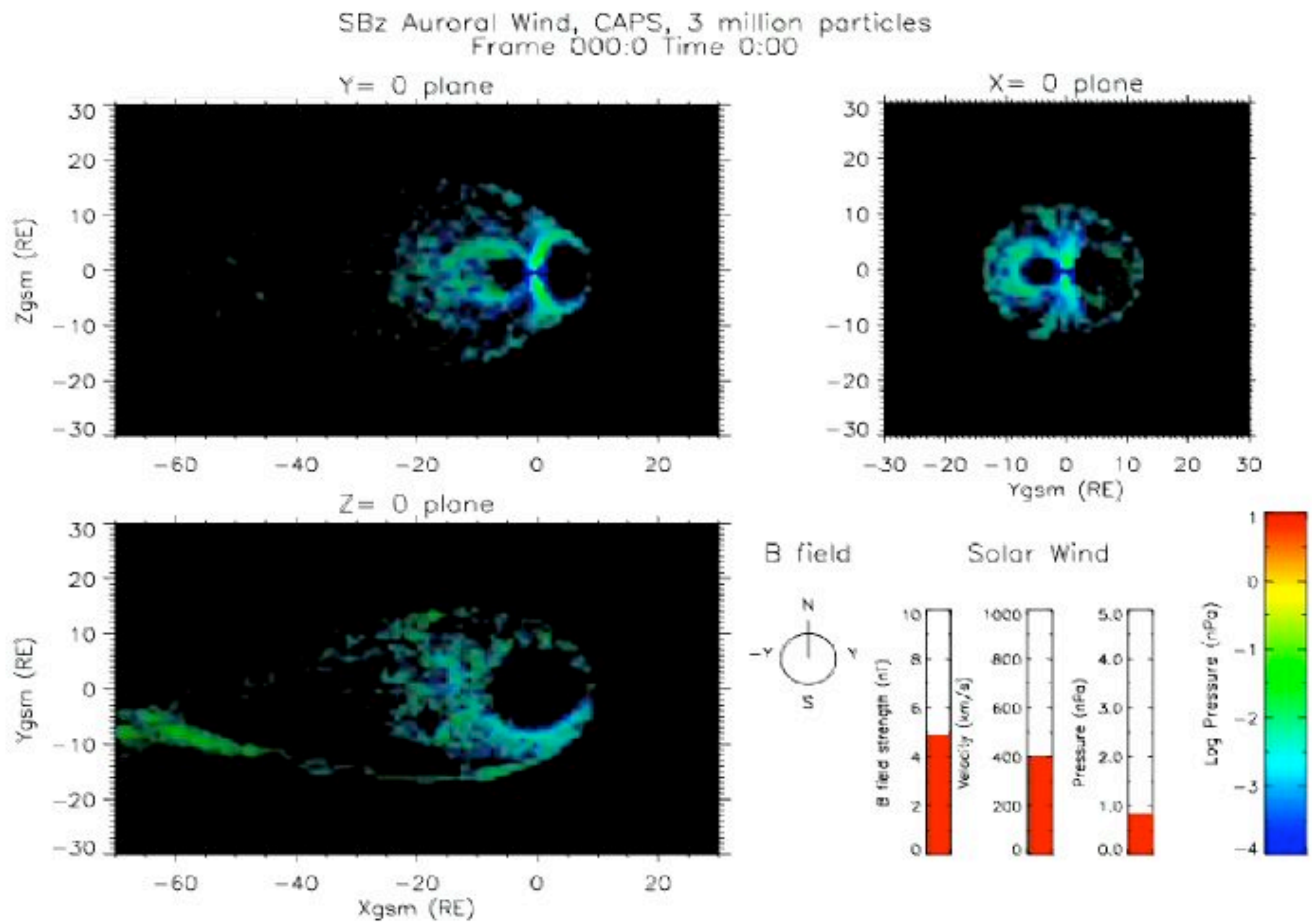
Dynamic Boundary Conditions: SBz Excursion



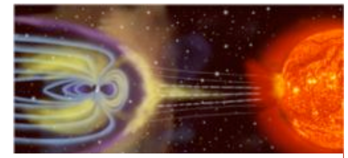


Dynamic Auroral Wind: SBz Excursion





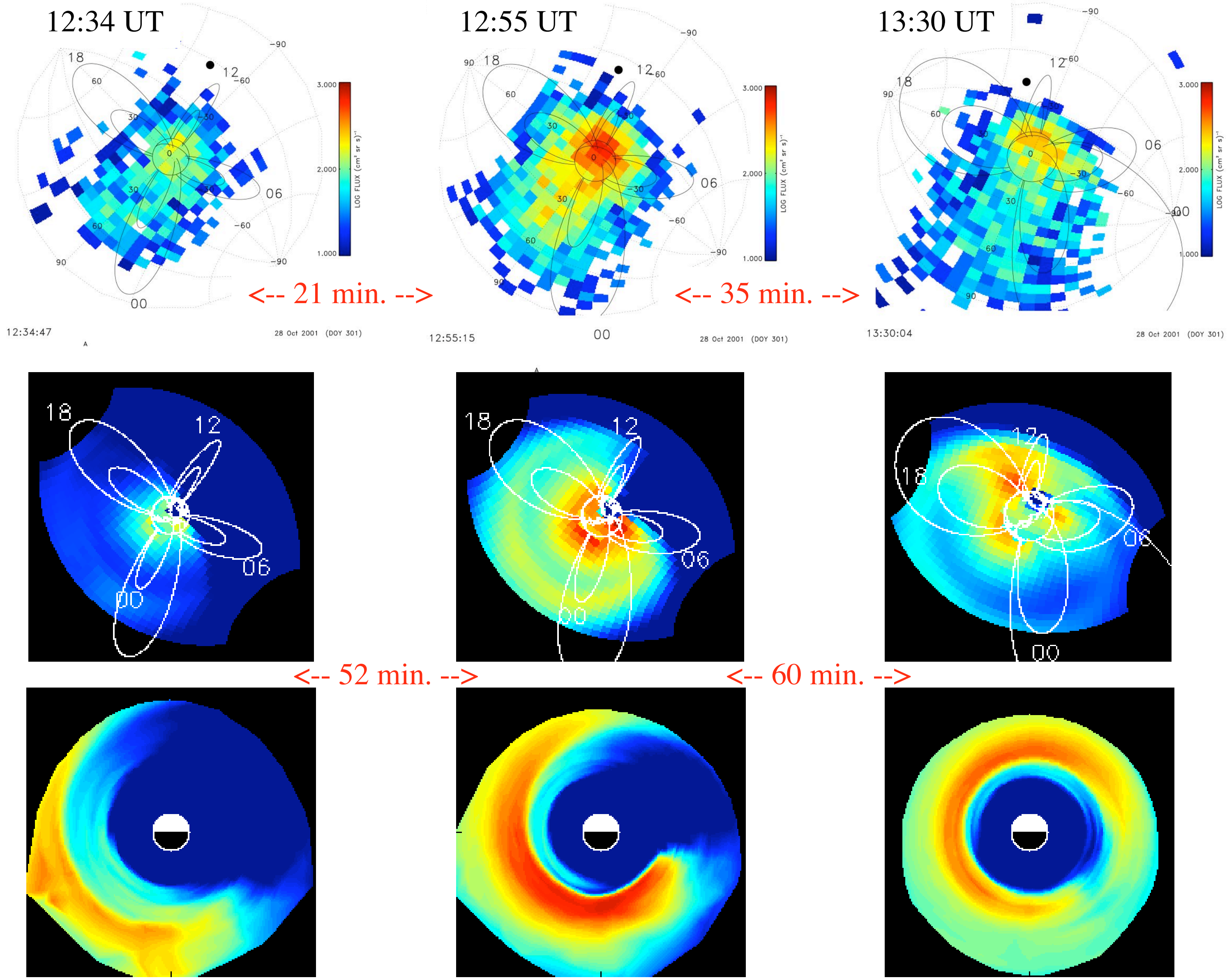
Substorm O+ ENA: Data - Model



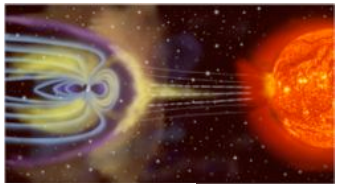
HENA O
50-180 keV
28 October 01

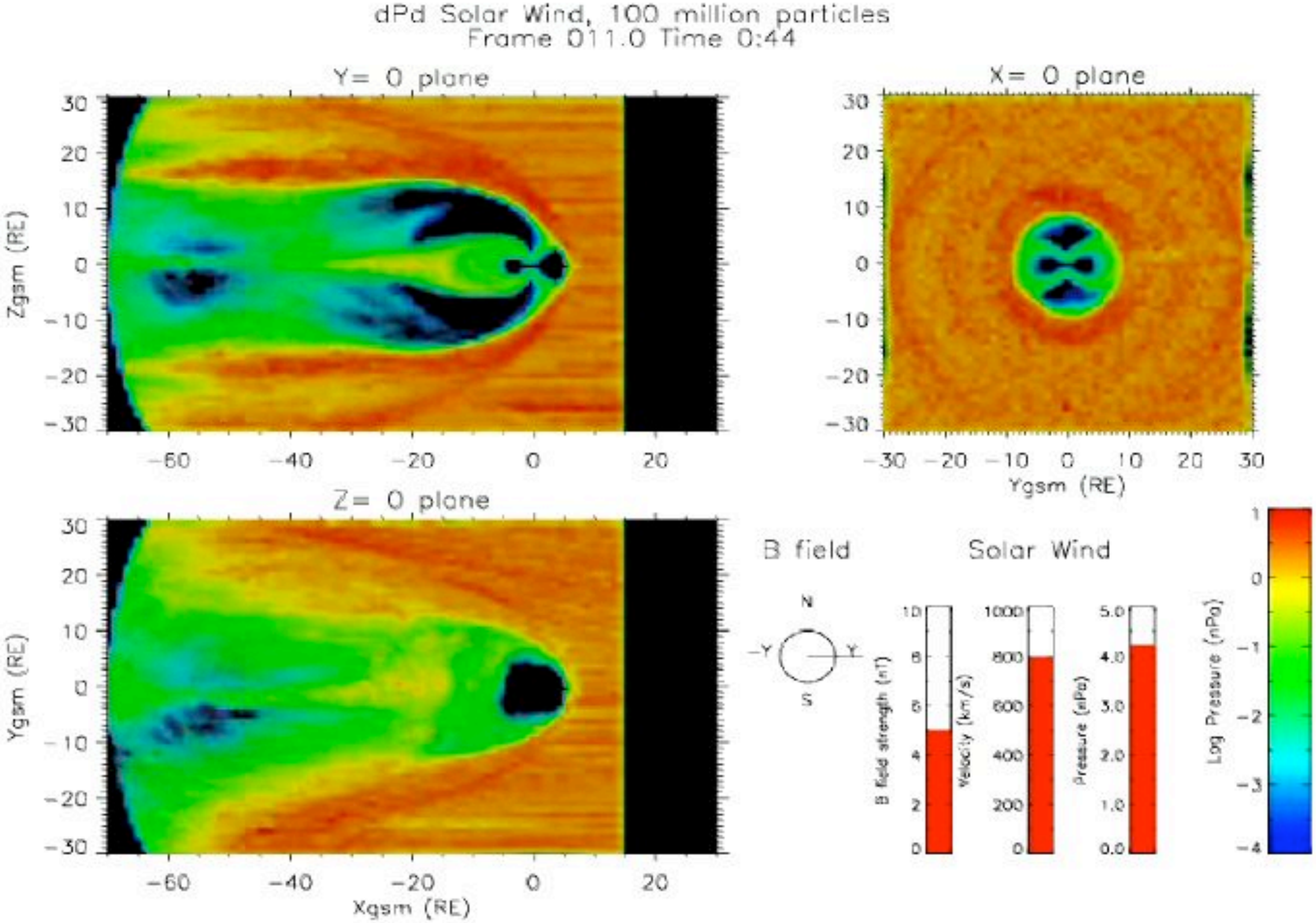
Simulated
O ENA

Simulated
O+

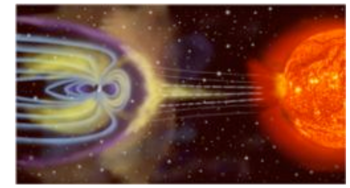


Dynamic Solar Wind: Pd Increase

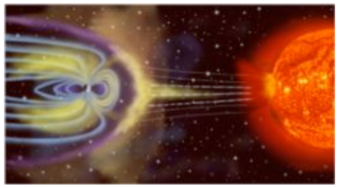


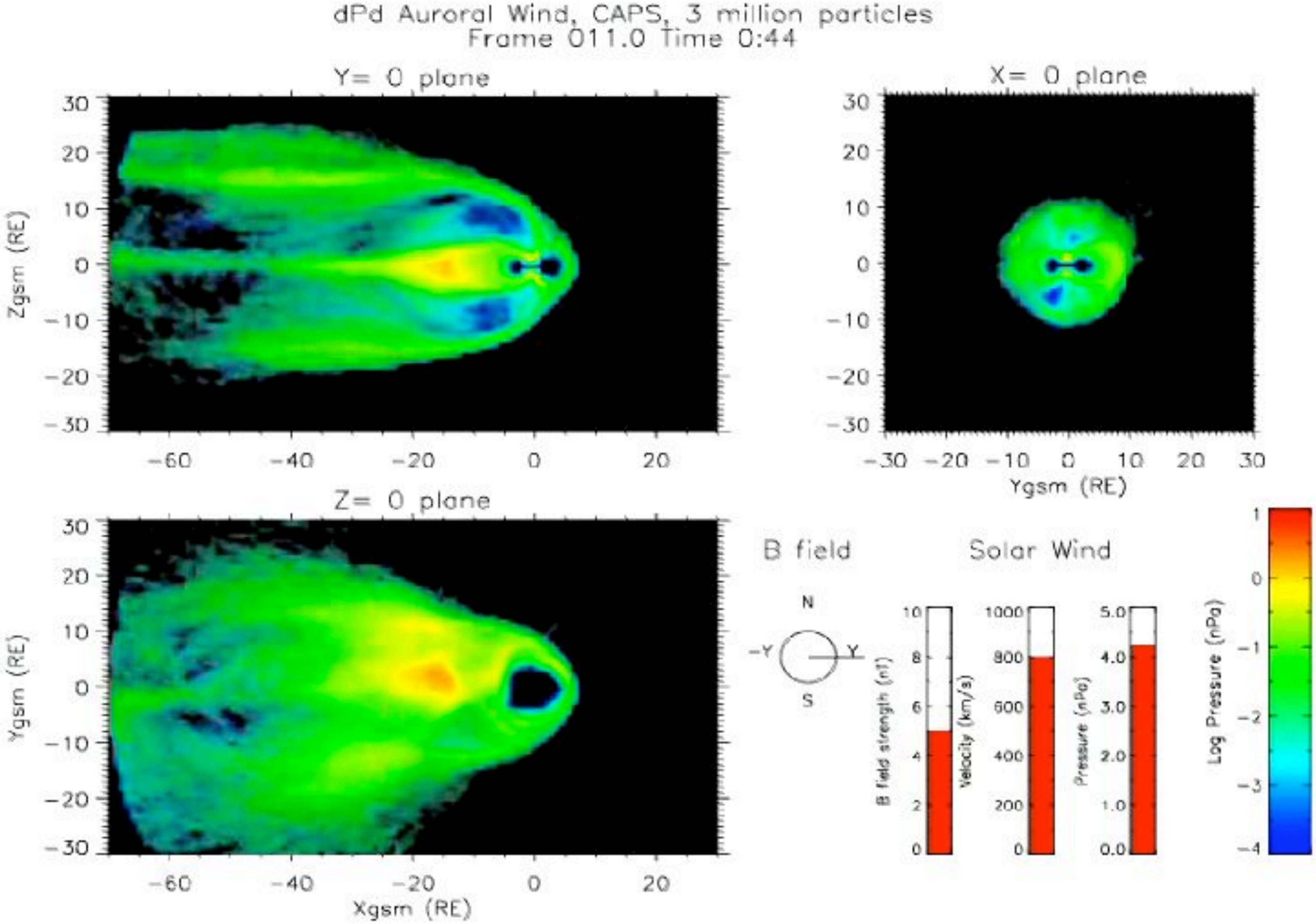


Dynamic Polar Wind: Pd Increase

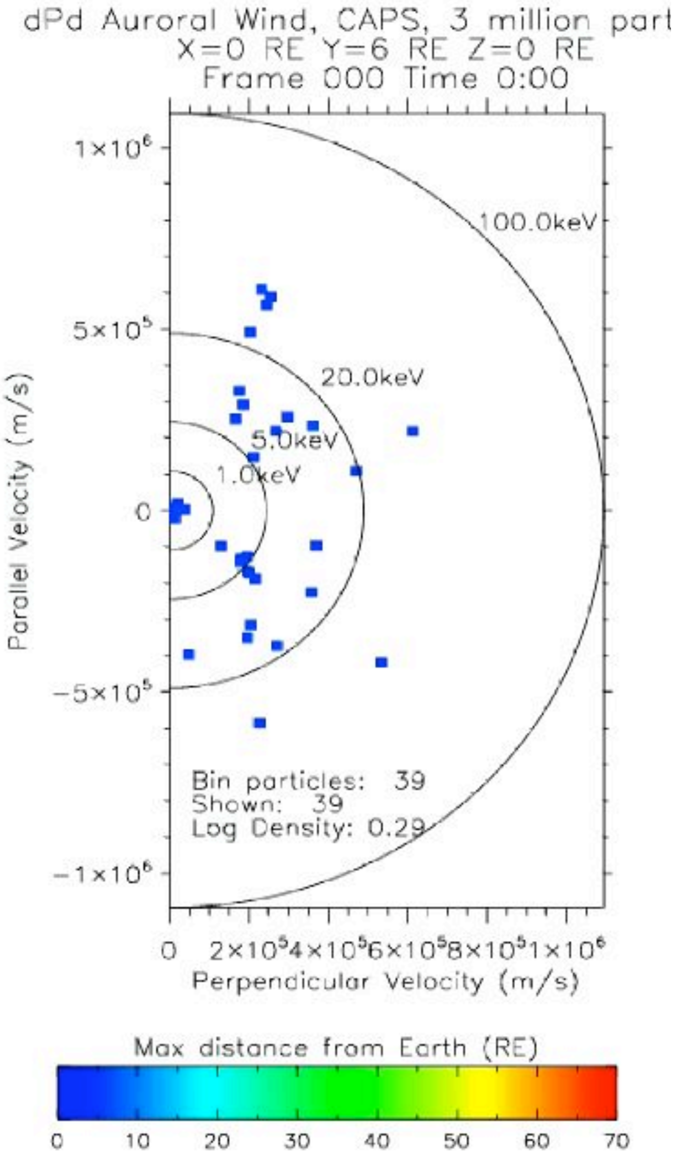


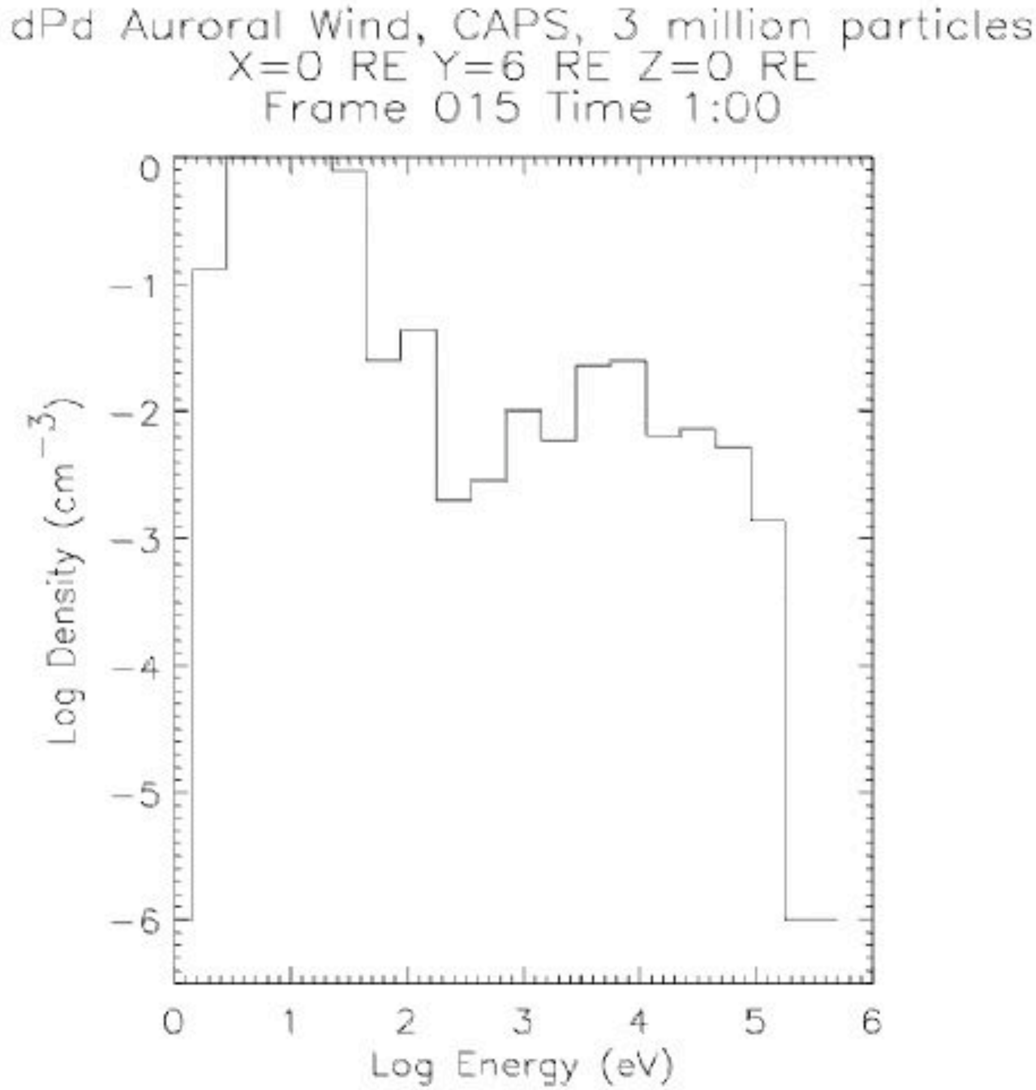
Dynamic Auroral Wind: Pd Increase





Virtual Spacecraft Dusk Geosync Region

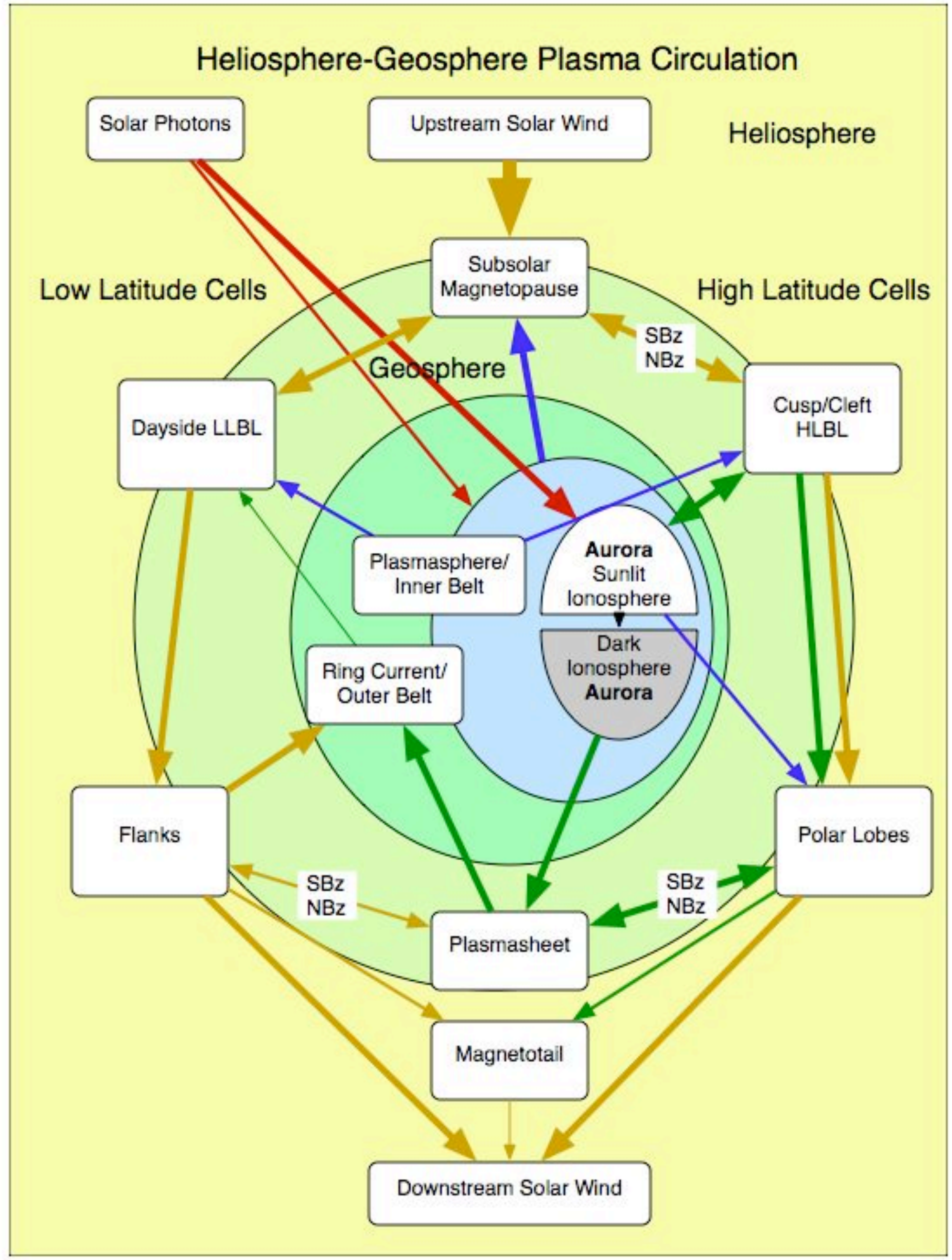




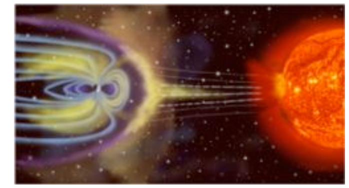
Integrated over pitch angle

H-G Circulation

- A plasma flow chart of the magnetosphere



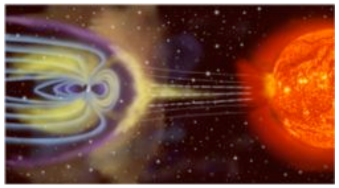
CONCLUSIONS



- Largest geospace storms supported by ionospheric ablation
- Driving auroral wind with local dynamic boundary conditions produces enhanced realism and detail
- Prolonged NBz *shuts down* the auroral wind.
- Substorms are triggered by both SBz, dPd
- Pre-existing auroral wind O^+ outflows are highly compressed by solar wind pressure increase
- Auroral wind O^+ increases with pressure increase, but delayed

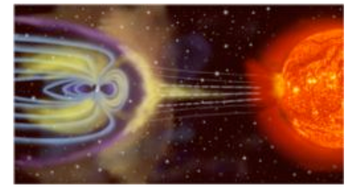
Future Work

- Combined SBz and dPd in realistic storm sequences.
- Simulations with ionospheric plasmas as dynamical elements, e.g. Winglee code, others?
- Simulations with realistic inner magnetospheric fields, e.g. BatsRUS with CRCM, others?

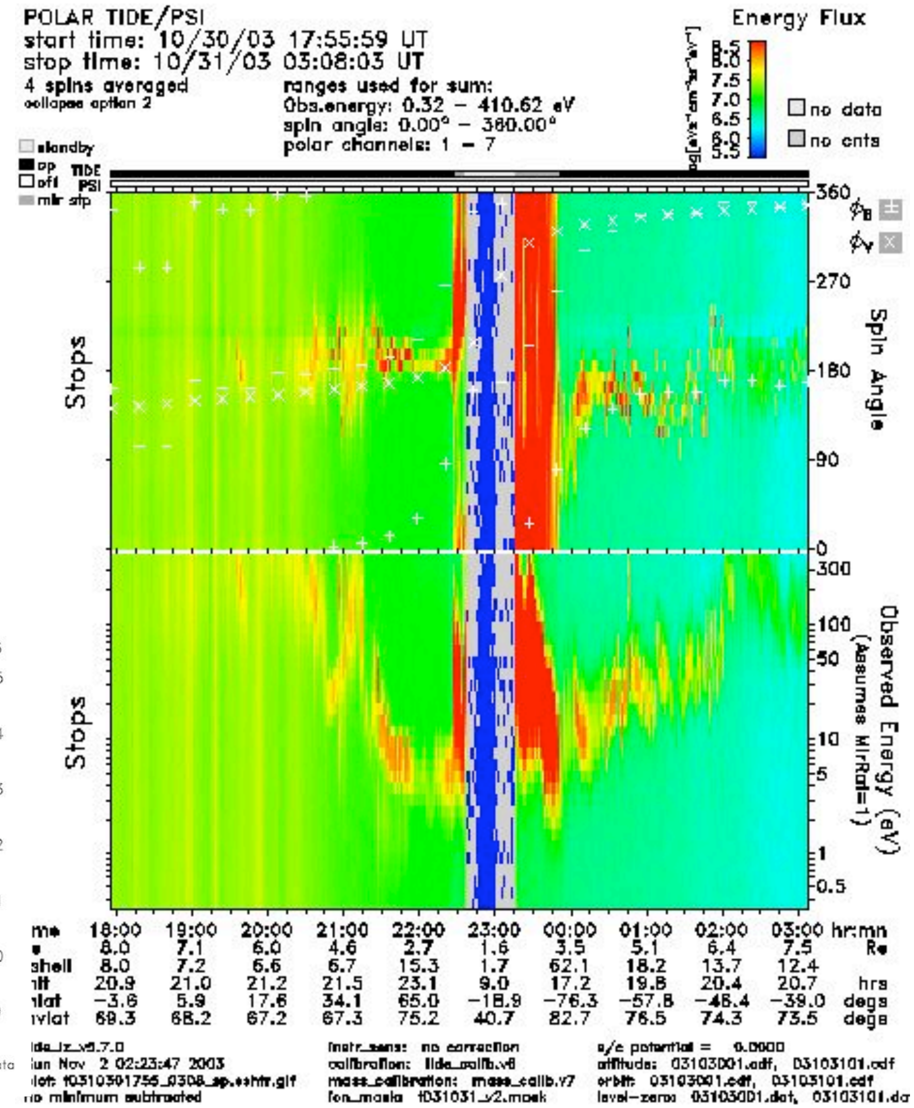


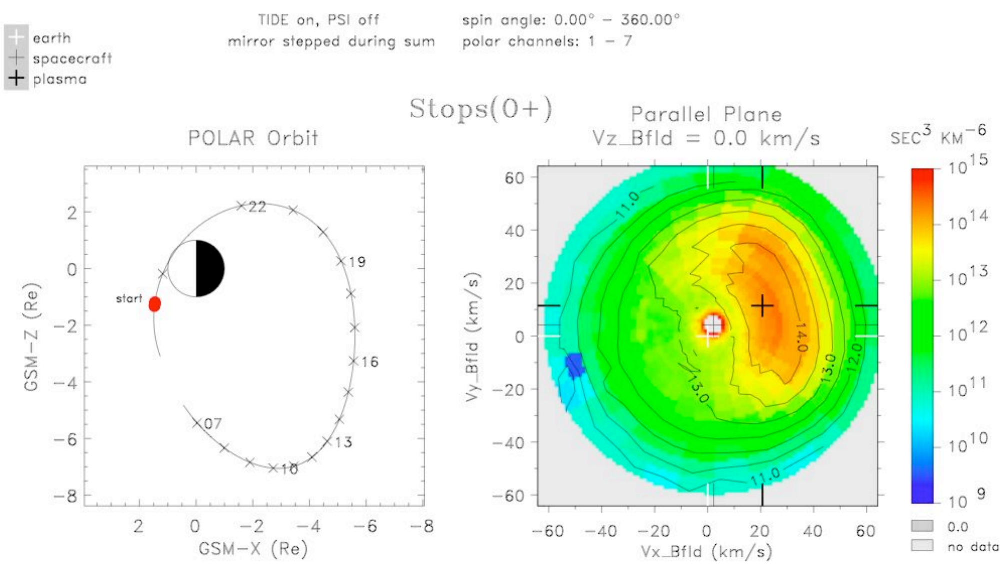
Backup/Discard Charts

TIDE Outflow Observations



- Polar perigee pass occurs near peak ring current
- Largest outflow flux event seen by Polar in dayside cusp: 1.5×10^{10} $cm^{-2}s^{-1}$ =
- 10 x 24-25 Sept 1998 IME
- Nightside auroral outflow comparable but cooler





Dynamic Particle Boundary Conditions: Pd Increase